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Various threatening factors to the biodiversity of insect pollinators in Himachal Himalaya, India

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Abstract

The climate and soil of Himachal Himalaya is suitable for growing various kinds of fruit crops. The fruit crops grown here are apples, almonds, peaches, plums, pears, cherries, walnuts and pine nuts in the mountain regions and citrus fruit, mangoes, litchis, guavas, and loquat in the foothills and in the plains. Himachal Pradesh is known as the 'Fruit State' and the 'Apple State' of India. The services of insect pollinators are required for the sustainability of agricultural/horticultural and natural ecosystems. Among insects, bees, flies, butterflies, beetles, wasps, moths, and midges are important pollinators of many crops. It has been estimated that over 80% of all flowering plants depend on biotic pollinators, especially bees. The annual contribution of pollinators to agricultural crops has been estimated globally at about USD 200 billion, and USD 365 million for Himachal Pradesh. In the recent years, yield and quality of fruit crops is diminishing due to insufficient pollination. The number, abundance and biodiversity of insect pollinators is decreasing due to hazardous human activities. Various threatening factors to the biodiversity of insect pollinators observed in Himachal Himalaya are: - loss of habitat; introduced species; mono-cropping; grazing and mowing; Forest fires; Honey hunting; Exotic honeybees and local honeybees; Pesticides; Diseases and parasites; Cell phone radiations; Environment pollution, and Climate change. The decline in pollinator diversity, presents a serious threat to crop production and the maintenance of biodiversity. Several orchardists in Himachal Pradesh, have destroyed their apple trees being discouraged by the very low yields and the inferior quality of apples due to poor pollination. Many farmers are hiring honeybee colonies for the pollination of their orchards to cope up the decline in natural pollinators.

Keywords: Himachal Himalaya, Pollinators decline, Apple crop, Threatening factors, Habitat loss, Climate change

Introduction

The services of insect pollinators are very important for the sustainability of agricultural/horticultural and natural ecosystems. It has been estimated that over 80% of all flowering plants depend on animal pollinators, especially bees. The annual contribution of pollinators to agricultural crops has been estimated globally, at about USD 200 billion and USD 365 million for Himachal Pradesh. New research and development challenges to maintain horticultural productivity in mountain agro-economic systems have arisen due to diversification of agriculture and ever increasing human population. One among these several challenges is crop failure due to lack of pollination, which needs for changed strategies and look for other possible inputs for increasing crop production. There are many factors responsible for the decline of insect pollinators, including the loss, degradation and fragmentation of habitat; introduced species; habitat disruption from grazing, mowing and fire; the use of pesticides; diseases and parasites, climate change and mono-cropping (Raj and Mattu, 2016). Many fruit crops grown in Himachal Himalaya areapples, almonds, peaches, plums, pears, cherries, walnuts, and pine nuts in the mountains and citrus fruit, mangoes, litchis, guavas, and loquat in the foothills and in the plains. Apples are the main cash crop, accounting for 42% of the total area under fruit cultivation and about 88% of total fruit production. Therefore, Himachal Pradesh is known as the 'Fruit State' and the 'Apple State' of India (Raj et al. 2012).

Insect Pollinators

Pollinators are external agents which help in the transfer of pollen grains from one flower to another of the same or another plant of the same species. The pollination process is based on the ecological principle of species' inter-relationship known as 'proto-cooperation', between plants and pollinators. There are two types of crop pollinators found in nature: abiotic and biotic. Abiotic pollinating agents are wind, water, and gravity. Many agricultural crops, especially those that produce dry pollen such as rice, wheat, maize, millet, chestnuts, pecan nuts, and walnuts are successfully pollinated by wind. Biotic pollination agents include insects, birds, and various mammals. Among insects, bees, flies, beetles, butterflies, midges, moths, and wasps are important pollinators of many crops. Pollinators visit the flowers of plants to obtain their food, i.e., nectar and pollen, and in return pollinate them (Raj et al. 2012). Most crops would produce no fruit or seed without the pollination of their flowers. Poor pollination often results in reduced crop yields and deformed fruits. Pollination services are vital for the production of a wide range of agricultural crops, as well as for the maintenance of surrounding natural ecosystems (De Groot et al. 2002; Eardley et al. 2006).It is revealed that "perhaps one-third of our total diet is dependent, directly or indirectly, upon insect pollinated crops". In the world of insects, different species of bees including honeybees, bumble-bees, stingless bees, and solitary bees are the most effective pollinators of crops. Over 25,000 species of bees are reported to pollinate over 70% of the world's cultivated crops McGregor (1976).

Various threatening factors to insect pollinators

In recent years, pollination services are being hampered by a decline in the number, abundance, and diversity of pollinator populations throughout the Himalayan region. The inadequate pollination in apples orchards is largely attributed to decline of natural pollinators such as honey bees. This is forcing farmers to find different ways of managing the pollination of their apple orchards (Partap, 2001; Partap and Partap, 2002).Human activities and practices are primary factors in the loss of habitats of pollinators leading to a decrease in their food supplies, nectar, and pollen. Other major factors contributing to pollinator decline include an increase in monoculture-dominated agriculture and the negative impacts of modern agricultural interventions such as the use of pesticides (Ahmad et al. 2003; Partap, 2010a,b, 2011). Some of the possible factors for pollinator decline in context to Himachal Himalaya are reviewed here: -

1. **Disturbance, degradation, fragmentation, shrinkage, and the loss of habitat**

Farmers in the high mountain regions of Himachal Himalaya are planting apples in their pasture lands. Himachal Pradesh has observed an increase of 135% in apple orchards. The ongoing increase in agricultural and horticultural area, at the cost of forests and grasslands, is apparently leading to the loss of nesting sites and food sources of pollinators. The negative impact of agricultural intensification on the abundance of natural insect pollinators has been shown by studies conducted by many scientists (Partap, 2001). Klein et al. (2007) reported that agricultural intensification jeopardizes wild bee communities and their stabilizing effect on pollination services. The loss of critical resources has devastating consequences for insect populations and communities. The removal of dead and decaying wood from boreal forests during traditional timber harvesting practices is considered to be the primary mechanism responsible for the decline in saproxylic beetle diversity and the large number of Red Listed species in boreal forests globally (McGeoch et al. 2007). About the impacts of human disturbances on bees, Winfree et al. (2009) identified habitat loss and fragmentation as the most significant factor in declines of abundance and species richness of bees. Factors causing habitat loss and fragmentation include increasing urbanization, expansion of intensive agriculture, invasive plants, and climate change. These reduce, degrade, and/or eliminate pollinator habitat. In some cases, however, the impact of urban and agricultural expansion can be reduced by providing alternative food resources and nesting sites for bees and other pollinators (Kremen et al. 2002b; Winfree et al. 2008). Habitat loss, degradation, and fragmentation are linked to declines in pollinator diversity and abundance (Frankie et al. 1990) that is followed by a reduction in pollination services (Kremen et al. 2002a). They also can cause decreased population size and/or low population densities of pollinator species (Kearns et al. 1998; Spira, 2001) or changes in pollinator community composition (Brosi et al. 2008). Diversity and reproduction of native flowering plants may also be affected by decreases in pollinator species diversity and population size (Jennersten, 1988; Spira, 2001). The causes of pollinator declines are often difficult to identify, but are likely due to a combination of factors that include isolation time, isolation distance, size of the fragment, and the surrounding environment (Rathke& Jules, 1993). If habitat becomes fragmented and the distance between patches is greater than the foraging range of pollinators, patches too small to support their own pollinators will suffer from lack of pollination services (Kearns et al. 1998). Williams & Kremen (2007) found that in an agricultural landscape, increasing distance to natural habitat in conventional farms was correlated with decreased reproductive success in wild bees.

2. **Impact of introduced species**

Biological invasion is recognized as one of the major threats to biodiversity worldwide, along with habitat loss and climate change. The accidental (and sometimes deliberate, such as for agriculture or biological control) introduction of alien species, including plants, microbes, vertebrates, and other invertebrates, is also of major concern to insect conservation. Alien invasive plants may impact negatively on insect biodiversity by changing habitat quality, outcompeting native host plants, and interrupting vital ecological interactions. Social insects, in particular ants and wasps, have established themselves worldwide as successful alien invasive species. A range of life history traits associated with sociality in insects appear to facilitate successful invasion (Moller, 1996). Introduced nonnative plants compete with native plants for resources as well as alter habitat composition, and some cause significant reductions in the abundance and diversity of pollinators and other herbivorous insects. There is also evidence that native pollinator insects prefer native plants (Samways et al. 1996; Spira, 2001; Hopwood, 2008).

3. Increase in mono-cropping

The cultivation of large and adjoining areas under a single crop is known as mono-cropping or monoculture. Although, it provides ample forage for pollinators over a limited flowering period, yet practically available forage before and after the main flowering period, may not commensurate with the requirements of pollinating agents. The replacement of natural plant communities by monoculture, is also a declining factor since most monocultures are not capable of sustaining pollinator populations (Raj and Mattu, 2016). In the past, mountain farmers grew a variety of crops, which bloomed at different times of the year and provided food for a number of natural insect pollinators. The transformation of agriculture from traditional mixed crop farming to high value cash crop farming in recent years has led to an increase in monocrop agriculture, reducing the food sources for natural insect pollinators. Reports from several mountain areas indicate that mountain farmers are switching on a large scale to the cultivation of cash fruit crops and off-seasonal vegetables (Partap, 1998, 2001; Partap and Partap, 2002).

4. Grazing and mowing

The grazing and mowing can have damaging impacts on pollinators but when carefully managed, they can be beneficial. Historically, there were sufficient areas in various stages of succession to support populations of habitat specific pollinators. However, now that many of these areas exist only as patches in larger agricultural or other intensively managed landscapes, and consideration of pollinators is needed to ensure healthy populations.

Livestock grazing can greatly alter the structure, growth, and diversity of the vegetation community, which in turn can affect the associated insect community (Kruess & Tscharntke, 2002). Grazing during periods when floral resources are already scarce (mid-summer) may result in insufficient forage available for pollinators such as bumble bees which, in some areas, forage into late September (Carvell, 2002). Likewise, grazing during spring when butterfly larvae are active on host plants can result in larval mortality or remove important vegetation and nectar resources. Ways that grazing can harm pollinator habitat include: destruction of potential nest sites, destruction of existing nests and contents, direct trampling of adult bees, and removal of food resources (Sugden 1985). Studies of livestock grazing on bees also suggest that increased intensity of livestock grazing negatively affects the species richness of bees (Vazquez &Simberloff, 2003).Grazing in natural areas, if not managed appropriately, the ecological impact of it can be severe (Bilotta et al. 2007).

Like grazing, mowing can alter grassland succession and species composition by suppressing growth of woody vegetation (Forrester et al. 2005). Mowing can have a significant impact on insects through direct mortality, particularly for egg and larval stages that cannot avoid the mower (Di Giulio et al. 2001). Mowing also creates a sward of uniform height and may destroy topographical features such as grass tussocks (Morris, 2000) when care is not taken to avoid these features or the mower height is too low. Such features provide structural diversity to the habitat and offer potential nesting sites for pollinator insects such as bumble bees. In addition to direct mortality and structural changes, mowing can result in a sudden removal of almost all floral resources for foraging pollinators. Therefore, it should not be conducted when flowers are in bloom.

5. Forest fires

Forests provide food sources, and habitats for nesting and hibernation for a variety of pollinator species. Studies have revealed that there are more insect pollinators in apple orchards situated near forests than those that are far from forests (Sharma and Gupta, 2010). Therefore, a decline in forest area either by its conversion to farmland or destruction in other ways (such as forest fires) has a negative impact on pollinator abundance. Forest fires in summer, largely engineered by farmers for fresh growth of grass on forest floors, is a key factor affecting pollinator populations in some areas. Forest fires not only destroy the nesting places and food sources of pollinators but also kill pollinators hibernating or nesting in the area. The large-scale pine plantations in the mid hills of the Himachal Himalaya pose a fire hazard in summer because of the falling of dried pine needles. It is common practice for farmers in the Himalayan region to use fire in the fields and grasslands to control weeds and to improve the quality of grass the following year. The removal of weeds reduces the diversity of food sources available to pollinating insects. Afraid of being stung, farmers also burn and poison *Apisdorsata*colonies and other pollinators in India (Partap et al. 2012).

Fire has played an important role in many native ecosystems, and controlled burns are an increasingly common management tool. Effects of fire management on arthropod communities are highly variable. If used appropriately, fire benefits many insect communities through the restoration and maintenance of suitable habitat (Huntzinger, 2003; Hartley et al. 2007). Other studies have found a negative or mixed response of invertebrates to fire (Harper et al. 2000; Moretti et al. 2006). Furthermore, Moretti et al. (2006) found that it can take 17-24 years for insect communities in burned areas to recover to pre-burn composition. Fire can have serious impacts on population levels and unless there are adequate refuges from the fire or adjacent habitat, recolonization of a burned site may not be feasible. Timing of burns is also critical and should not be carried out when target pollinators are in a larval or critical foraging stage. Habitat patches should not be burned completely, but rather a mosaic of burned and unburned areas is ideal.

6. Honey hunting

An increase in honey hunting and the ruthless hunting of the nests of wild honeybees is contributing to the decline in the population of indigenous honeybees (Partap, 2010b). While in the past, honey hunting formed a part of the culture and tradition of honey-hunting communities and provided them with a source of income. It is now being commercialized and exploited by big contractors and companies.

7. Exotic honeybees and local honeybees

The introduction of exotic honeybee species can adversely affect populations of native bee species. This may be because of competition for food, the transfer of pests and diseases from one species to another or economic preference for exotic species. The introduction of *Apismellifera*to increase honey production has led to a decline in beekeeping with indigenous *Apiscerana*in mountain region (Partap and Partap, 1997).

8. Pesticides

The use of pesticides, including insecticides and herbicides, is detrimental to a healthy community of pollinators. Insecticides not only kill pollinators (Johansen, 1977), but sub-lethal doses can affect their foraging and nesting behaviours (Thompson, 2003; Desneux et al. 2007), often preventing pollination. Herbicides may kill plants that pollinators depend on when crops are not in bloom, thus reducing the amount of foraging and egg-laying resources available (Kremen et al. 2002b; Tscharntke et al. 2005).Generally, while pesticide labels may list hazards to honey bees, potential dangers to native bees and other pollinators are often not listed. Many native bees are much smaller in size than honey bees and are affected evenby lower doses. Pollinator larvae are also harmed by consuming food contaminated with pesticides (Johansen & Mayer 1990; Abbott et al. 2008). In the eve of cash crop farming, farmers use insecticides and pesticides indiscriminately, contributing to the decline in natural insect pollinators. Research (Partap, 2001, 2010b; Partap and Partap, 2001, 2002) revealed a serious lack of pollinators in apple farming areas because of the excessive and indiscriminate use of pesticides on apples and other cash crops. Apple farmers spray different pesticides (including insecticides) as many as 10 times in a season, and in Himachal Pradesh almost 31% of farmers spray during the flowering period (Table-1). Agricultural pesticides kill not only the foraging insects, but also *Apisdorsata*and *Apisflorea*colonies in adjoining areas.

Just as pollinators can influence the vegetation community, changes in vegetation can have an impact on pollinators (Kearns & Inouye, 1997). A pollinator community requires consistent sources of nectar, pollen, and nesting material during those times adults are active. The broadcast application of a non-selective herbicide can indiscriminately reduce floral resources, hostplants, or nesting habitat. Such a reduction in resources can cause a decline in pollinator reproductive success and/or survival rates.

Table 1: Number and time of spray of pesticides on apple crop in H.P. (Raj and Mattu, 2016).

		% age of responses
a.	**Number of pesticide spray per season**	
	3-4	10
	4-5	8
	6-7	15
	9-10	67
b.	**Period of spray**	
	Non-flowering	61.10
	Flowering	30.90
	Both	8.00
c.	**Time of spray**	
	Morning	52.20
	Afternoon	29.80
	Evening	18.00
d.	**Commonly used pesticides**	Metacid, metasystox, diethane M-45, thiodan, monocrotophos, fenitrothion, malathion

Kearns et al. (1998) stated that herbicide use affects pollinators by reducing the availability of nectar plants. In some circumstances, herbicides appear to have a greater effect than insecticides on wild bee populations. Some of these bee populations show massive declines due to the lack of suitable nesting sites and alternative food plants. There is also the potential for sub-lethal effects such as a decreased ability to fly and an increase in flower handling time. Hormonal herbicides alter the chemistry of plant secretions such as nectar which in turn may cause harmful effects to pollinators foraging on that contaminated nectar. Ingestion of herbicides by other insects, such as species of Coleoptera and Lepidoptera, has varying effects depending on the species, life stage of the species, and the chemical (Brown, 1987; Russell and Schultz, 2009).

There are two general categories of effects that native pollinators may experience as a result of coming into contact with insecticides or insecticide residues; lethal and sub-lethal. Lethal effects are most easily recognized i.e. the dosage is sufficient to result in near immediate mortality of the insects. While there are reports of native pollinator die-offs in non-laboratory conditions, many such poisonings are assumed to go unreported because the bees are unmanaged and do not gather in large aggregations. Low fecundity rates mean it can take many years for a native pollinator population to recover from a large reduction. Native bees in laboratory conditions were found to produce 15 – 20 offspring per year (Tepedino, 1997). In a natural setting this number is expected to be less due to competition, predation and parasites (Kearns & Inouye, 1997). Lethal effects on honey bees are often the primary focus of regulatory procedures for assessing the safety of a new insecticide for pollinators despite the enormous diversity of bees, butterflies, and other pollinating insects that may have a wide variation in their response to the same insecticide (Abramson et al. 2004; Abbott et al. 2008). As a result, a pesticide that has been deemed safe for honey bees when used according to the bee label may not be safe for native bees or other pollinators. Sub-lethal effects refer to a suite of impacts that may inhibit or degrade pollinator function and/or life history, possibly across multiple generations (Desneux et al. 2007). Sub-lethal effects are often difficult to measure and little work has been done to thoroughly investigate their significance in native pollinator populations (Alston &Tepedino, 2000). Sub-lethal effects impact native pollinator communities in many ways. These include a decrease in forage efficiency, decline of reproductive success and fitness, increase in immunological disorders, and a decrease in learning ability (Decourtye et al. 2004, 2005; Thomson, 2003). Despite the long-term repercussions that these symptoms may have on an ecosystem few pesticides are tested for sub-lethal effects prior to regulatory approval. The usage of broadband insecticides in wild areas may potentially result in a number of ecosystem shifts due to pollinator limitation. These include “changes in future vegetation patterns via plant competition, reduction in seed banks, and influences on the animals’ dependent upon plants for food” (Alston &Tepedino, 2000).

9. Pests, predators, diseases, and parasites

The common predators of insects are amphibians (frogs, toads), birds, mammals (Bear), wasps, and greaterwax moth& lesser wax moth. The best evidence of specific pollinator decline is seen in the western honey bee, *Apismellifera* L., the primary commercial pollinator of agricultural crops and the most widely used, actively managed pollinator in the world (Delaplane and Mayer, 2000; Kearns et al., 1998). The population losses among honey bees are due to pests, parasites, and pathogens, mostlyby parasitic mites *Varroa destructor*(Morse and Flottum, 1997) and *Acarapiswoodi* Rennie (tracheal mite), and the pathogen *Paenibacillus larvae* (American foul-brood, AFB). *Paenibacillus larvae* or formerly *Bacillus larvae* (White, 1920) is the most serious honey bee pathogen. It causes AFB, a disease of larval honey bees. AFB is highly virulent and easily spread among colonies as a result of beekeeper activity and bee behavior, and it is generally fatal if untreated (Shimanuki, 1997). During the first half of the 20th century, AFB was the most serious threat to beekeeping, and it caused tremendous loss of colonies, amounting to hundreds of thousands in the 1940s (Barrett, 1955). The incidence of AFB was reduced dramatically by the introduction of antibiotics and the burning of infected hives. Honey bees are also attacked by diseases like Nosema dysentery caused by a protozoan *Nosemaapis* and Thai sac brood disease (from Thailand) caused by *Morator* species of virus.

10. Cell phone radiations

Sharma and Kumar (2010) have compared the performance of exposed and unexposed honey bee colonies in cell phone radiation. A significant decline in colony strength and in the egg laying rate of the queen was observed. The behaviour of exposed foragers was negatively influenced by the exposure. There was neither honey nor pollen in the colony at the end of the experiment. Radiation from the cell phone influences the behavior and physiology of adult workers of *Apismellifera* L (Kumar, 2011). There was reduced motor activity of the worker bees on the comb initially, followed by mass migration and movement toward “talk mode” cell phone. The initial quiet period was characterized by rise in concentration of biomolecules including proteins, carbohydrates and lipids, perhaps due to stimulation of body mechanism to fight the stressful condition created by the radiations. At later stages of exposure, there was a slight decline in the concentration of biomolecules probably because the body had adapted to the stimulus. The author has also observed number of bees dyeing either losing the location of their colonies or behavioural disorder due to electro-magnetic radiations.

11. Environment pollution

Pollutants in the air, water and land always affect the physiology and behavior of the insects. Changes in the carbon-nutrient balance in plant tissues as a result of increases in carbon dioxide will reduce the nutritional quality of plant tissues and alter production of secondary compounds. Predicted effects for insect herbivores with chewing mouth parts, include increased first-instar mortality, increased development time and consumption, and decreased digestive efficiency and performance. Lower development rates may also increase herbivore mortality from natural enemies and result in asynchronous plant–insect life cycles (Bale et al. 2002). Fuentes (2008) observed that air pollution from automobiles and power plants has been inhibiting the ability of pollinators such as bees and butterflies to find the fragrances of flowers. Pollutants such as ozone, hydroxyl and nitrate radicals bond quickly with volatile scent molecules of flowers, which consequently travel shorter distances intact. There results a vicious cycle in which pollinators travel increasingly longer distances to find flowers providing them nectar, and flowers receive inadequate pollination to reproduce and diversify.

12. Climate change

Climate change is one of the major forms of environmental change impacting biodiversity of insects. The effects of climate change on insects will differ between species depending on their biology, current environment, and geographical distribution. As a result, some species are likely to be more susceptible to climate change than others. One of the important characteristics of the response of biodiversity to climate change is that species tend to respond individualistically. In other words, entire assemblages do not respond in a similar way, rather, each species in the assemblage tends to respond in a more or less unique fashion (McGeoch et al. 2006), as they have done in the prehistoric past (Ponel et al. 2003).

Increase in mean temperature, and higher winter and evening temperatures, can have profound effects on invertebrates. Although, increased temperatures in general result in increased development rates and a forward shift in phenologies, survival, distribution, migration, dispersal activity, range size and position, activity periods, and food consumption rates will also be affected (Hughes 2000; Walther et al. 2002). Interactions between species are predicted to be significantly altered by climate change, particularly when interacting species respond differently to the change. It is the interaction between the effect of climate change on insect life history and the resulting changes in phenology (timing of life history events) that will be important in determining how insects respond to climate change. Water availability is one of the most important determinants of the distribution and abundance of insects. Because of their small body size, insects are particularly vulnerable to water loss, and water loss rates are positively related to precipitation levels (Chown and Nicolson, 2004). Increased frequency of extreme events, such as floods, droughts, and fires, will increase mortality and may result in extinction of restricted-range species.

Effects of Decline in Pollinators

Most of the crops and varieties cultivated in Himachal Himalaya are mainly cross-pollinated and either depends on, or are greatly benefited by, insect pollination. The decline in pollinator diversity, distribution, and abundance presents a serious threat to crop production and the maintenance of biodiversity. Among the different crop categories, fruit crops are highly vulnerable to pollinator loss. It is estimated that a loss in local insect pollinators would result in a two-thirds reduction in fruit crop production. Oilseed crops are the next most vulnerable, followed to a much lesser degree by pulses, spices, and vegetables. Apple farming plays a major role in the economy of Himachal Pradesh. The decline in natural insect pollinators causes low crop yield, and deformed, discolored and poor fruit quality, despite of adequate agronomic inputs and intensive efforts. Pistil senescence and low seed production are also results of poor pollination. Disappointed with the very low yields and the quality of apples as a result of poor pollination, several farmers have destroyed their apple trees. Orchardists in Himachal Pradesh are hiring honeybee colonies for the pollination of their apple orchards to equalize the decline in pollinators.

Conclusions

In spite of suitable climate and soil conditions for growing different fruit crops in Himachal Himalaya, and adequate agronomic inputs and intensive efforts of orchardists, the yield and quality of fruit crops is decreasing, due to insufficient pollination. In recent years, number, abundance and biodiversity of insect pollinators is decreasing due to hazardous human activities. Various threatening factors to the biodiversity of insect pollinators observed in Himachal Himalaya are: - Disturbance, degradation, fragmentation, shrinkage, and the loss of habitat; Impact of Introduced species; Increase in monoculture; Grazing and mowing; Forest fires; Honey hunting; Exotic honeybees and local honeybees; Pesticides; Diseases and parasites; Cell phone radiations; Environment pollution; and Climate change. These factors are imposing a serious threat to crop production and the maintenance of biodiversity. Several farmers getting disappointed with the very low yield and quality of apples, have destroyed their apple trees. So we need more research to find out new methods, plans and policies for conservation and management of insect pollinators not in Himachal Himalaya only, but a global concern.

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